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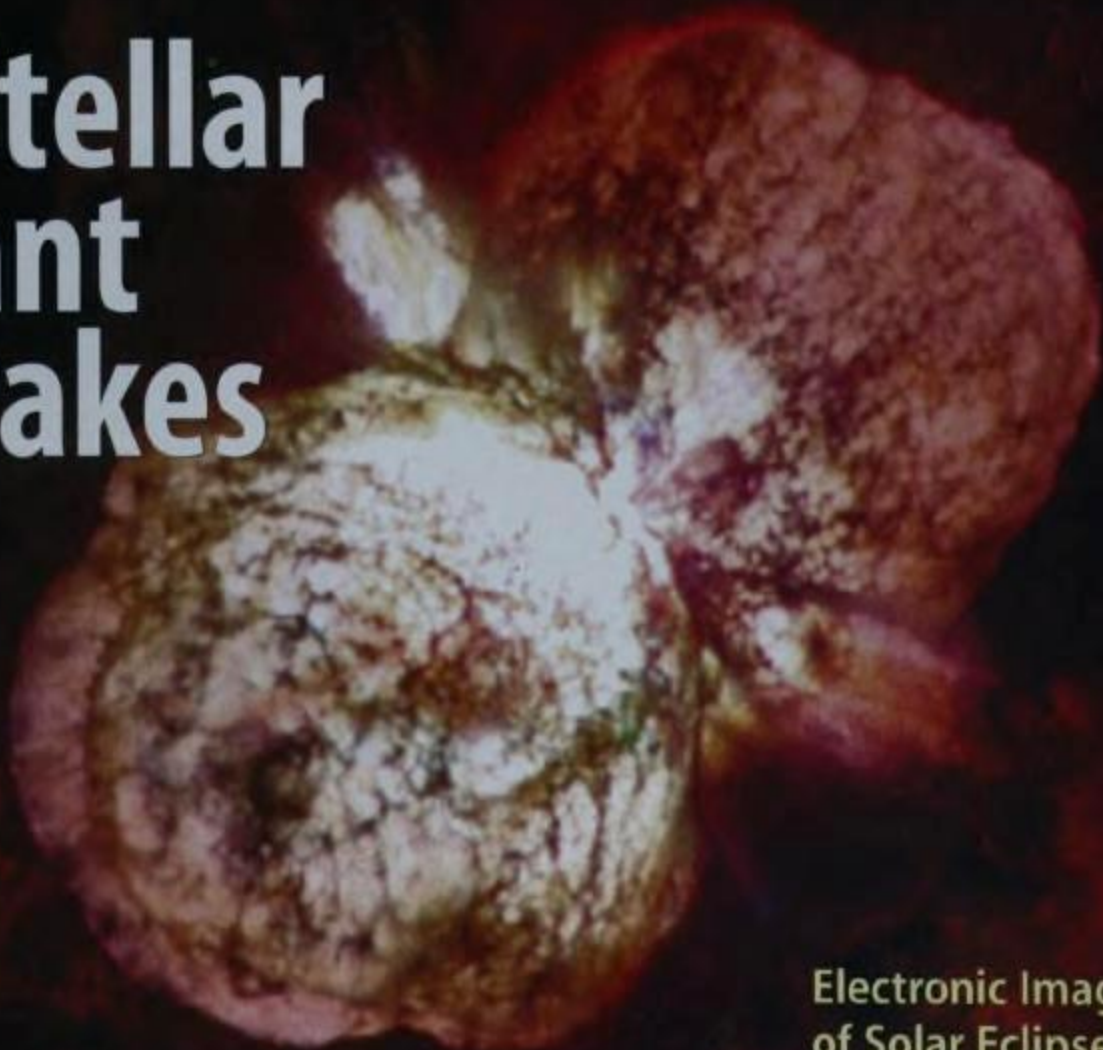

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# O'Neill's Bridge Remembered

*His "confirmation" and continued belief that the Moon harbored a natural bridge ultimately damaged the otherwise distinguished reputation of a skilled lunar observer* | **By Thomas A. Dobbins and Richard M. Baum**

THE MOST EYE-CATCHING FEATURE of the three-day-old waxing crescent moon is Mare Crisium or Sea of Crises. Completely encircled by lofty mountains that call to mind the rugged coastline of Norway, it is the best preserved of the Moon's great lava-flooded impact basins. Its location near the lunar limb results in a foreshortened perspective that makes the mare appear as a dusky oval elongated in a north-south direction. In reality the formation measures some 270 miles from north to south and 350 miles from east to west — slightly larger than the state of Iowa.

Mare Crisium is an even more impressive sight three days after full Moon, when the lunar evening terminator sweeps across the region. Mountain peaks on the western shore tower to heights of 12,000 feet and glisten in the sunlight, while below on the mare's surface a sprinkling of craterlets and a host of low ridges stand out in bold relief.

It was under grazing sunset illumination that John J. O'Neill was surveying the western extremities of Mare Crisium with a 4-inch refractor at 90× in the wee hours of July 29, 1953. The science editor of the *New York Herald Tribune*, O'Neill today is remembered chiefly as a confidant and biographer of the maverick inventor Nikola Tesla. On that night, however, he was destined to make an observation for which he would be remembered in the world of amateur astronomy.

The surface of Mare Crisium already lay in shadow except for a curious fan-shaped patch of light diverging from a small bay on its western shore. Two capes jut into this bay — Promontorium Lavinium from the south and Promontorium Olivium from the north. Connecting these headlands, O'Neill glimpsed a narrow line

**Mare Crisium, the Sea of Crises, shows as a distinct, dark, circular feature on this Lick Observatory photograph. While this view has celestial north up, all other lunar illustrations with this article have south up to match the view in an astronomical (inverting) telescope. Shortly after John J. O'Neill reported a "natural bridge" on the western edge of Mare Crisium, Paul Roques photographed the region with the 12-inch refractor at California's Griffith Observatory. One day separates the left and center images, while the view at right was made about six hours after the one at center.**

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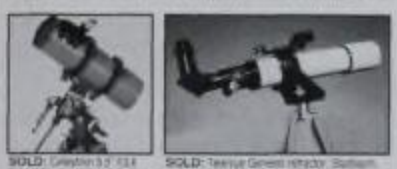

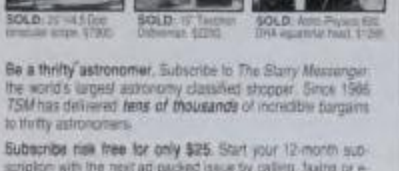

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**Hugh Percy Wilkins (in dark suit) was the keynote speaker at the July 1954 Astronomical League national meeting in Madison, Wisconsin. Two weeks earlier, Wilkins had used the 60-inch reflector at California's Mount Wilson Observatory to study the region around O'Neill's Bridge — an observation that would forever damage his credibility as a lunar observer. *Sky & Telescope* photograph.**

**Wilkins sketched O'Neill's Bridge with the 60-inch reflector on the night of June 17, 1954. His views, separated by a half hour, show what appears to be an arch's shadow growing longer as the Sun dips lower toward the lunar horizon.**

of light that persisted when he increased the magnification to 250×. He interpreted this delicate feature not as a ridge but as a "gigantic natural bridge having the amazing span of about twelve miles from pediment to pediment." The rays of the setting Sun seemed to be streaming underneath the span to illuminate the slowly retreating patch of light on the mare surface to the east. Here, it seemed, was a colossal lunar counterpart to the spectacular natural bridges found in the southwestern United States.

O'Neill wasted no time in announcing his discovery and requesting confirmation by observers equipped with more powerful telescopes. The following day he fired off letters to prominent figures, including Walter Haas, director of the Association of Lunar and Planetary Observers (ALPO), and Hugh Percy Wilkins, director of the British Astronomical Association's (BAA) Lunar Section. Wilkins was renowned for the exhaustively detailed 300-inch Moon map he had issued seven years earlier, the product of decades of painstaking work at the eyepiece.

Wilkins received O'Neill's report with considerable skepticism, having studied the region on many occasions without ever suspecting anything unusual. On the night of August 26th, when lighting conditions were once again similar to those at the time of O'Neill's sighting, Wilkins turned his 15-inch Newtonian reflector on the area, "firmly convinced that I was about to debunk the whole affair."

To his surprise, a magnification of 300× revealed "a bridge with sunlight streaming under it, and the shadow of the arch cast on the surface of the plain." O'Neill had imagined that the shadow of the arch fell beyond the terminator, but Wilkins claimed he could actually see it drift slowly eastward as the Sun dipped lower on the lunar horizon. The feature detected by Wilkins, however, was only two miles long, one-sixth the length alleged by O'Neill.

Wilkins immediately wrote O'Neill to conditionally endorse his discovery and offer congratulations, only to learn that the New York amateur had died suddenly shortly before the letter arrived. In September tentative confirmation trickled in from a handful of other British observers.

On the other side of the Atlantic events were taking a very different turn. Excerpts of O'Neill's letter to Walter Haas appeared in the October 1953 issue of the ALPO's journal, *The Strolling Astronomer.*

Haas harbored grave doubts that such an enormous structure could have gone unnoticed by previous generations of selenographers. He had cautiously withheld publication of the news until the region could be examined with the 12-inch Zeiss refractor at Griffith Observatory in Los Angeles. As a disclaimer, a preliminary report by Paul Roques of the Griffith staff accompanied O'Neill's report.

It was immediately apparent to Roques that both Promontorium Lavinium and Promontorium Olivium rapidly diminish in elevation as they converge. O'Neill's "fan of light" could be easily explained as sunlight shining through this pass and falling on gently rising terrain to the east. Roques could distinguish that Promontorium Lavinium had a blunt, beaklike tip, while Promontorium Olivium terminated in a long, narrow ridge that extended to the west of Promontorium Lavinium, separated by a narrow gap. O'Neill's 4-inch refractor lacked the resolving power required to discern these all-important topographic details.

Soon prominent amateurs in Britain were confirming Roques's interpretation of the lunar sighting and refuting Wilkins. O'Neill's Bridge, if you'll pardon the pun, was collapsing. Were it not for an unfortunate twist of fate, the episode might have been all but forgotten as a mere curiosity — a striking example of those lunar illusions that result from the interplay of light and shadow. Wilkins's confirmation would have been excused as an incautious lapse. It would have been a minor blemish on an otherwise distinguished record of accomplishment.

But O'Neill's letter happened to be sitting on Wilkins's desk during a recorded interview by BBC reporter Bernard Forbes about subjects ranging from recent developments in astronomy to flying saucers. Wilkins had casually referred to O'Neill's correspondence during the conversation. The edited version of the interview that was broadcast, however, left listeners inferring that the structure was not only indisputably real but that it might also be artificial! Wilkins later lamented, "My experience has been that it does not matter how carefully you explain things to most reporters, they always get things wrong!"

The sensational story was picked up by the Associated Press and ran in American newspapers during the closing days of December 1953. Members of the BAA were horrified that one of the organization's most prominent figures was attracting so much attention by spouting nonsense. A minor scandal ensued, culminating in an acrimonious debate at the November 1954 BAA meeting in London.

During the meeting, Wilkins related that while on a lecture tour in the United States the previous June he had used the 60-inch reflector at Mount Wilson Observatory to study the region of O'Neill's

**Harold Hill is internationally known for his lunar drawings. His rendering of the western "shore" of Mare Crisium was made under late-afternoon illumination. O'Neill's bridge was believed to span the gap between Promontorium Lavinium and Promontorium Olivium. The video image was captured by author Dobbins at 7:52 Universal Time on July 15, 1995. He offers it as "testimony to Harold Hill's unsurpassed skills both as observer and draftsman." The arrowed feature is mentioned in the text.**

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**While features like Utah's Owachamo Natural Bridge are familiar sights on Earth, they have no known counterparts on the Moon. This view with Comet Hale-Bopp was recorded last April 30th.**

Bridge under favorable lighting and "on one of those rare occasions when details become crystal sharp." The presence of a 1½-mile-wide "hole or aperture in the rocky upper portion of a cliff" on Promontorium Olivium was revealed. While admitting that O'Neill's 12-mile span was illusory, Wilkins now proposed that by a remarkable coincidence there really was an uncannily similar structure in that very location. It was, however, minute and accessible only to large apertures.

This rather implausible suggestion evoked a sarcastic response from Cambridge University astronomer W. H. Steavenson, Britain's leading professional lunar specialist: "If the bridge really is decreasing in length in this way, I fear it may now be too late for us to catch it!" He added the stinging rebuke: "The aperture of the telescope is not the only thing to be taken into account. There is also the man at the small end."

His credibility damaged, a bruised Wilkins soon resigned from the BAA, but he never withdrew his claim that something extraordinary is present at Promontorium Olivium. Wilkins died in 1960.

Images of western Mare Crisium made by the Lunar Orbiter space probes were obtained during midday lighting and are of little value in improving our understanding of the region. In recent years inexpensive video cameras have proved to be powerful tools for studying details of lunar topography at low sun angles (*S&T:* June 1996, page 94). Such a view of the region around O'Neill's Bridge made under late-afternoon lighting is reproduced on page 107. Taken from a videotape made with a 10-inch Newtonian reflector on a night of exceptionally good seeing, it captures a small sunlit elevation just to the east of Promontorium Olivium's ridge line. Is this the feature that Wilkins mistook for the spot illuminated by a beam of sunlight shining through a portal in Promontorium Olivium?

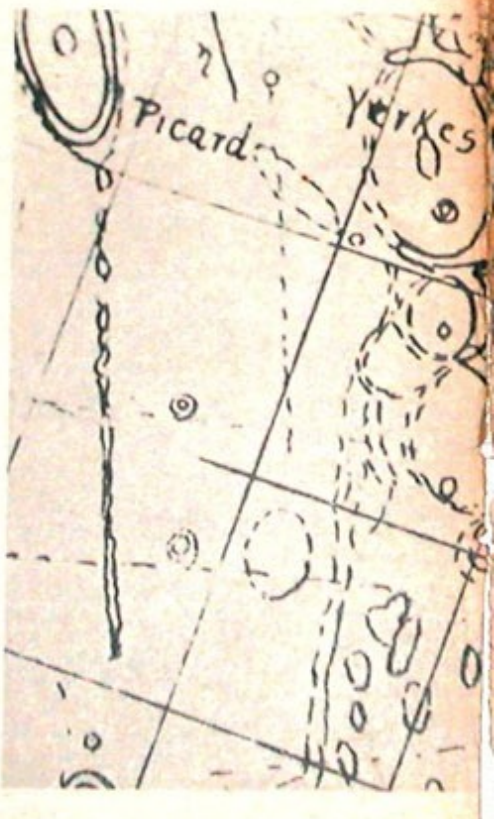
The French psychologist Gustav LeBon observed, "Many men easily do without the truth, but none is strong enough to do without illusions." The lighting conditions that deceived O'Neill and Wilkins occur when the Sun has a lunar colongitude near 127°. Dates when this happens in the coming months are given here. (Entries in boldface type are favorable for observers in the Western Hemisphere.)

| | |
|---|---|
| **November 1997** | **17–18** |
| December 1997 | 17 |
| January 1998 | 16 |
| **February 1998** | **14–15** |
| March 1998 | 16 |
| **April 1998** | **14–15** |

Turn your telescope to the region of O'Neill's Bridge on these nights and decide for yourself whether this strange, ephemeral appearance is sufficiently convincing that you would have staked your very reputation on a bridge's reality.

*Veteran planetary observer* Thomas Dobbins *maintains a special interest in the history of solar-system observation.* Richard Baum, *director of the BAA's Interior Planets Section, is a noted historian of astronomy.*

**IN THE TELESCOPE, THE TWENTY-MILE MOON BRIDGE IS JUST A SPECK**



Dr. Percy Wilkins has worked for sixteen years on his map of the moon, so big that it fills his living-room when it is unrolled. The newly discovered moon bridge, seen in an artist's impression (right), is twenty miles long and two miles wide, but appears as a minute speck in the telescopic picture of the moon (above). Its position, between two promontories, Lavinium and Olivium, is seen below on an enlarged section of Dr. Wilkins's map

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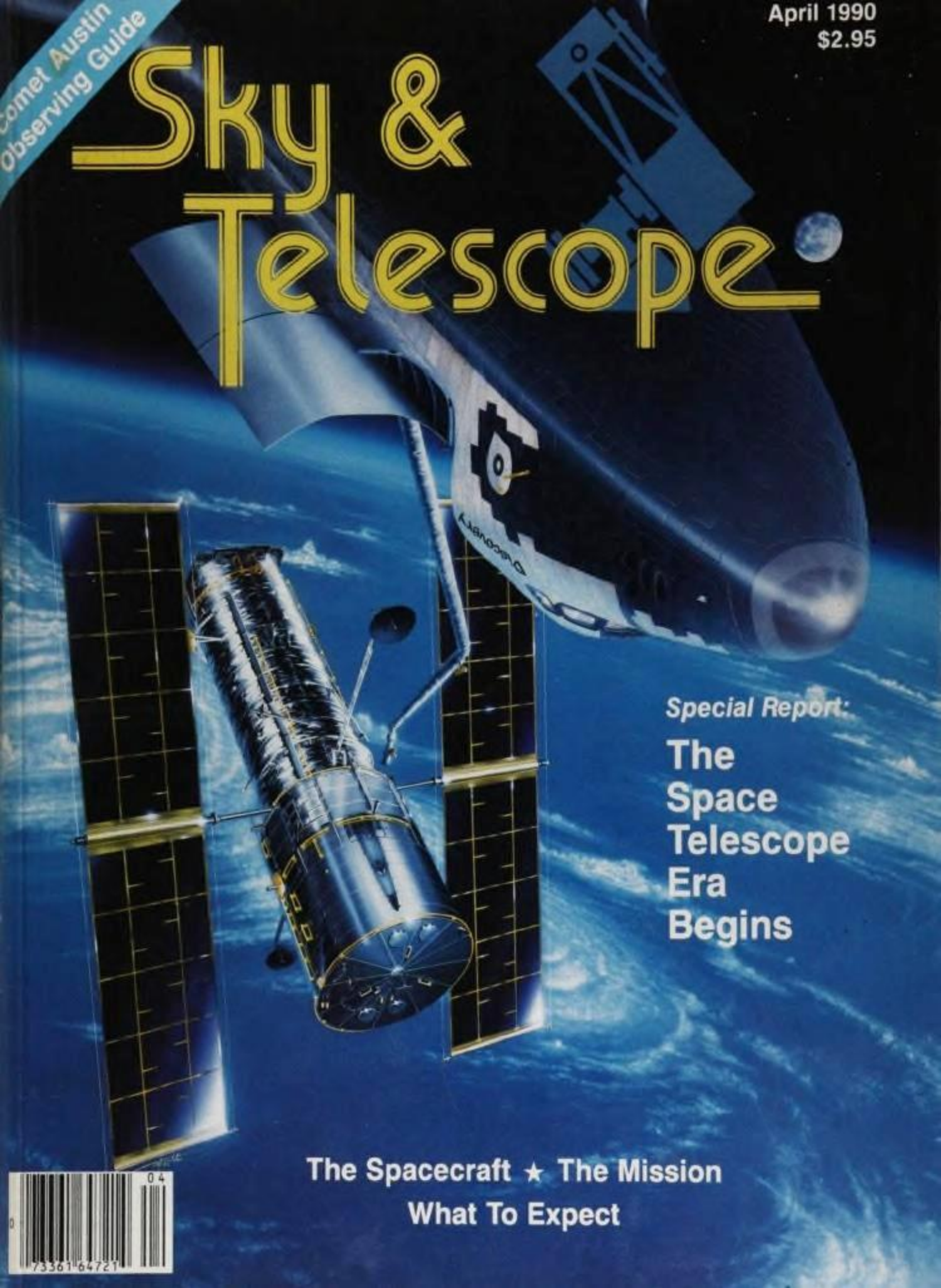
# Sky & Telescope



*Special Report:*

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# Edwin P. Hubble Space Telescope

### FAINT-OBJECT SPECTROGRAPH

| | | |
|---|---|---|
| *Prin. investigator:* | Richard Harms (Appl. Res.) | |
| *Prime contractor:* | Martin Marietta Corp. | |
| *Cost:* | $42 million | |
| *Mass, avg. power:* | 320 kg, 135 W | |
| *Detectors:* | 1 trialkali Digicon on $SiO_2$; 1 bialkali Digicon on $MgF_2$ | |
| *Pixel size, array size:* | 50 x 200 microns, 512-diode strips | |
| *Wavelength range:* | 1150-8500 angstroms | |
| *Apertures:* | 0".1 to 4".3 | |
| *Spectral resolution:* | 250 | 1,300 |
| *Limiting mag. (V):* | 26 | 22 |

*Remarks:* Has a "blue" detector optimized for 1150 to 5500 angstroms, a "red" detector for 1700 to 8500 angstroms; polarimetry in both channels.

### GODDARD HIGH-RESOLUTION SPECTROGRAPH

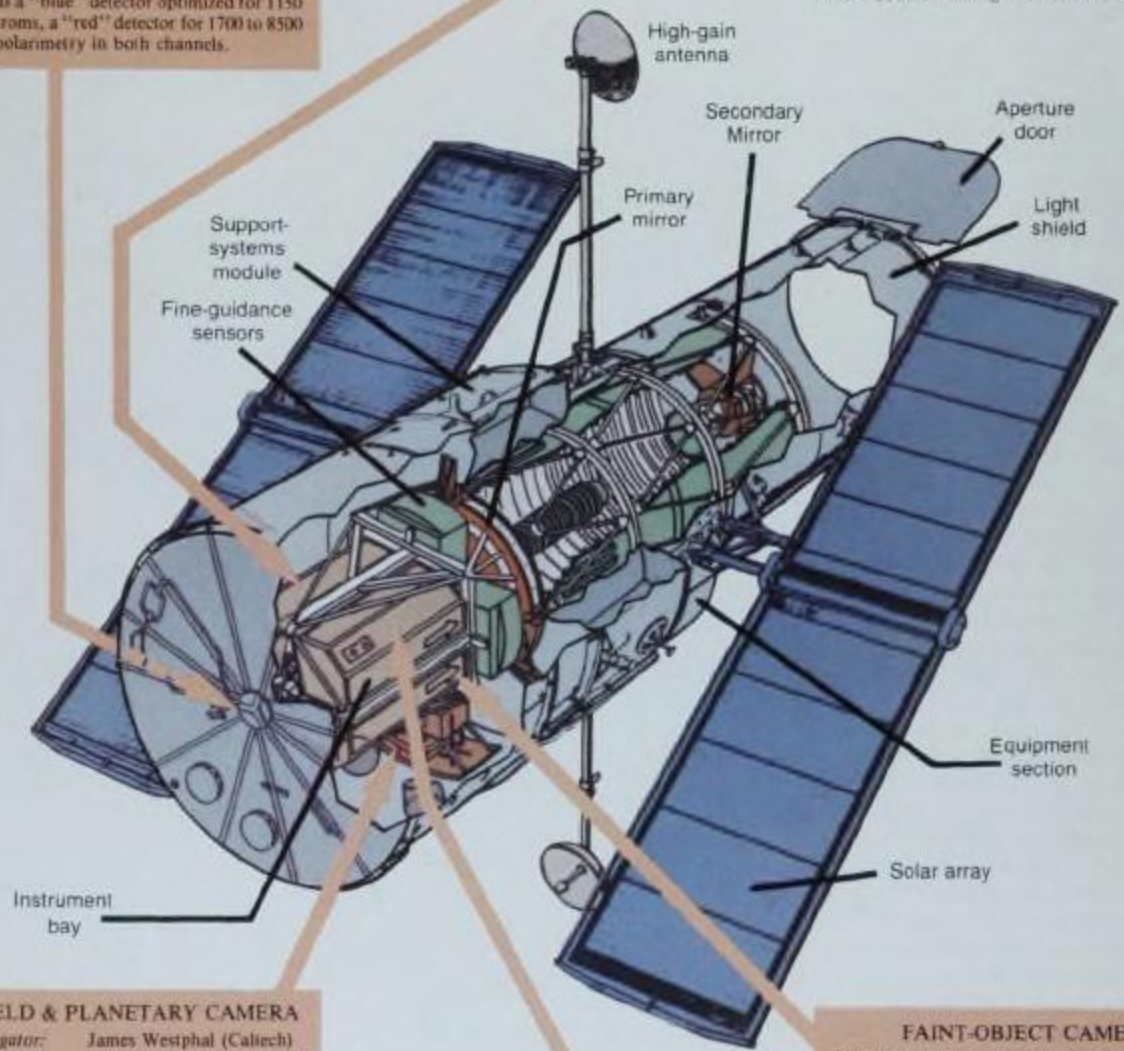
| | | | |
|---|---|---|---|
| *Prin. investigator:* | John C. Brandt (U. Colo.) | | |
| *Prime contractor:* | Ball Aerospace | | |
| *Cost:* | $42 million | | |
| *Mass, avg. power:* | 318 kg, 150 W | | |
| *Detectors:* | CsTe/MgF, CsI/LiF Digicons | | |
| *Pixel size, array size:* | 50 microns, 512-diode strips | | |
| *Wavelength range:* | 1050-3200 angstroms | | |
| *Apertures:* | 2".0 and 0".25 | | |
| *Spectral resolution:* | 2,000 | 20,000 | 100,000 |
| *Limiting mag. (V):* | 19 | 16 | 14 |

*Remarks:* Photon-counting detectors; low-resolution mode cuts off above 1800 angstroms; has automatic exposure meter; time resolution down to 0.05 second; six different gratings.

### HUBBLE SPACE TELESCOPE

| | |
|---|---|
| *Size (no booms):* | 13.1 x 4.3 m (43.1 x 14.0 ft) |
| *Mass:* | 11,600 kg (25,500 lb) |
| *Optical system:* | 2.4 m (94.5 in), Ritchey-Chrétien |
| *Obscuration:* | 14 percent (0.34 m secondary) |
| *Field of view:* | 18' for science, 28' for guiding |
| *Ang. resolution:* | 0".1 at 6328 angst., better in UV |
| *Spectral range:* | 1150 angstroms to 1 mm |
| *Point. stability:* | 0".007 for 24 hours |
| *Initial orbit:* | 610 km (380 miles), 28°.5 incl. |
| *Planned lifetime:* | 15 years (with maintenance) |
| *Spacecraft cost:* | $1.5 billion (1989 dollars) |

*Remarks:* None of the current instruments operates beyond 1.1 microns or uses more than a 2'.6 square field for imaging; prime optics contractor is Perkin-Elmer Corp. (now Hughes Danbury Optical Systems); prime spacecraft contractor is Lockheed Missiles and Space Co.; NASA-Marshall managed spacecraft development; NASA-Goddard managed instrument development.




### WIDE-FIELD & PLANETARY CAMERA

| | | |
|---|---|---|
| *Prin. investigator:* | James Westphal (Caltech) | |
| *Prime contractor:* | Jet Propulsion Laboratory | |
| *Cost:* | $65 million | |
| *Mass, avg. power:* | 292 kg, 190 W | |
| *Detectors:* | Eight CCD arrays | |
| *Pixel size, array size:* | 15 microns, 800 x 800 | |
| *Wavelength range:* | 1150-11,000 angstroms | |
| *Modes:* | f/12.9 | f/30 |
| *Field of view:* | 154" x 154" | 66" x 66" |
| *Angular resolution:* | 0".1 | 0".043 |
| *Limiting mag. (V):* | 28 | 27 |

*Remarks:* CCD's coated with coronene for better ultraviolet response; 48 filters provide narrow- and broad-band spectral windows plus three gratings for spectroscopy and three polarizers; single exposures from 0.11 to 3,000 seconds; CCD's require occasional ultraviolet irradiation; instrument must be warmed up to evaporate contaminants before far-ultraviolet imaging.

### HIGH-SPEED PHOTOMETER

| | |
|---|---|
| *Prin. investigator:* | Robert C. Bless (U. Wisc.) |
| *Prime contractor:* | University of Wisconsin |
| *Cost:* | $10 million |
| *Mass, avg. power:* | 273 kg, 135 W |
| *Detectors:* | 4 image-dissector tubes, 1 photomultiplier |
| *Wavelength range:* | 1200-9000 angstroms |
| *Apertures:* | 0".4 and 1" for science, 6" to 10" for targeting |
| *Limiting mag. (V):* | 24 |
| *Time resolution:* | Down to 0.01 millisecond |

*Remarks:* No moving parts; more than 100 filter-aperture combinations; can do ultraviolet polarimetry; can observe occultations.

### FAINT-OBJECT CAMERA

| | | |
|---|---|---|
| *Prin. investigator:* | F. Duccio Macchetto (ESA) | |
| *Contractors:* | Dornier, Matra Espace | |
| *Cost:* | $105 million | |
| *Mass, avg. power:* | 320 kg, 150 W | |
| *Detectors:* | 3-stage image intensifiers coupled to TV tubes | |
| *Pixel size, array size:* | 24 microns, 512 x 1,024 | |
| *Wavelength range:* | 1150-6500 angstroms | |
| *Modes:* | f/48 | f/96 |
| *Field of view:* | 22" x 44" | 11" x 22" |
| *Angular resolution:* | 0".043 | 0".022 |
| *Limiting mag. (V):* | 30 | 30 |

*Remarks:* Photon-counting detectors; f/96 channel has 3x zoom to f/288 for 0".007 resolution in ultraviolet over 3".6 x 7".3 field; larger fields at lower resolution are available in each mode; can operate as a long-slit spectrograph; has optional occulting fingers for viewing faint objects near bright ones.

# Delivering HST to Orbit

*Steven A. Hawley, NASA-Johnson Space Center*

WHEN THE Space Shuttle *Discovery* roars skyward on mission STS 31, it will carry one of the most anticipated payloads in recent history. At long last, the Hubble Space Telescope (HST) will be placed in orbit. The crew of STS 31 will play only a small role in the many events leading to HST's "first light" high above Earth's murky atmosphere. Still, as an astronomer and a crew member, I think our perspective on the mission is unique.

When *Discovery's* main engines shut down about 8½ minutes after liftoff, the orbiter is not yet in a safe orbit because the perigee is still well inside the atmosphere. However, about 20 minutes later we reach the initial trajectory's apogee of 380 miles (610 kilometers), about twice as high as orbiters normally go. At this point we raise the perigee by firing the orbital maneuvering system (OMS), the pair of rocket engines at the orbiter's rear.

Actually, given the propellant capacity of the shuttle's external tank, the apogee can be even higher. However, HST desires a circular orbit, and the perigee must be raised to match the apogee using the OMS. Unfortunately, the amount of OMS propellant is limited, and it is also what we burn to descend from orbit. The trick is to use just enough of it to put HST in the highest possible circular orbit, while still preserving the capability to leave orbit and land safely.

**All five crew members for STS 31 have flown on the Space Shuttle before. They are *(clockwise, from upper left)*: mission specialists Bruce McCandless II, Steven A. Hawley, Kathryn D. Sullivan, commander Loren J. Shriver, and pilot Charles F. Bolden, Jr. Courtesy S. Hawley.**

## FLIGHT DAY 1

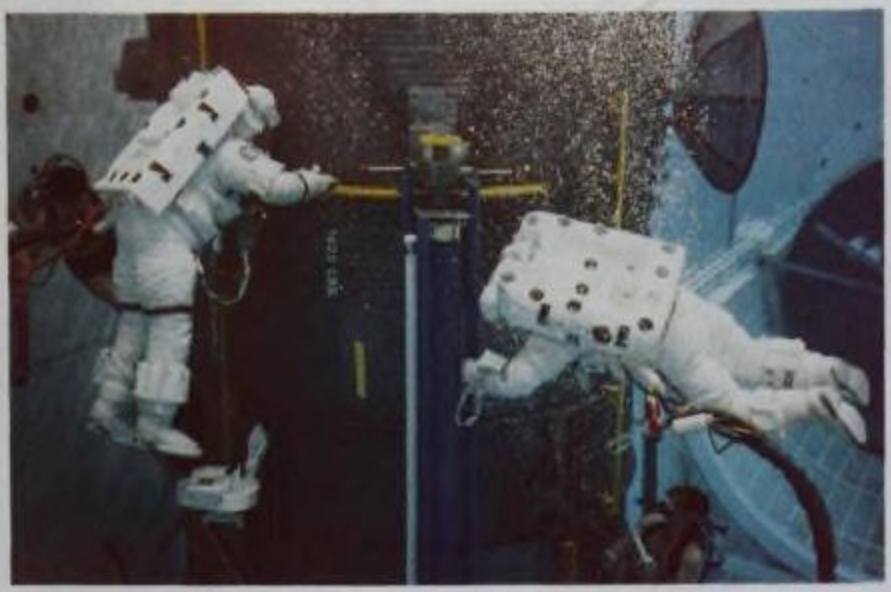
Among the housekeeping activities we perform during our first few hours in orbit are opening the payload bay doors and checking out the shuttle's remote manipulator system (RMS). This 50-foot-long robotic arm is articulated much like a human's and is attached to the orbiter at the forward, port (left) end of the payload bay. Its shoulder joint can move in two directions: yaw (side to side) and pitch (up and down). The elbow joint, located near the arm's halfway point, moves in pitch only, while the wrist joint can pitch, yaw, and roll. Attached there is the "end effector," whose snare of crisscrossed cables allows the arm to grasp a payload. However, this only works with a special appendage called a grapple fixture, two of which are mounted on HST.

Whoever operates the RMS actually "flies" the tip of the end effector, using a control station on the orbiter's flight deck that looks out over the payload bay. The operator moves the end effector using one of two hand controllers: one is for making translation movements and the other for changing the end effector's orientation. A computer then converts the command into motion of the individual joints. Manual control of each joint is possible, but complicated maneuvers are extremely difficult and tedious.

The RMS employs a coordinate system in which the X axis is oriented along the orbiter's length, Y is through the wings, and Z is perpendicular to the payload bay. Oddly, the origin of these axes was chosen to be the tip of the external tank, which means that while in orbit positions are referenced to a point in empty space off the nose of the orbiter. It's certainly not intuitive, but after some practice it becomes natural. Knowing how to position the end effector in these coordinates is extremely useful — in fact, it's a must — when dealing with large payloads and small clearances.

Of course, *Discovery's* crew and everyone in Mission Control are all interested in the condition of HST. After the RMS's checkout, I use a television camera mounted on the end effector to do a quick check of the telescope's thermal blankets, instrument covers, and anything else that might have been jostled loose during the orbiter's ascent. Meanwhile, throughout the day, the ground controllers send commands to HST to test its components and to load the programs that will control its operation in orbit.

The other major activity scheduled for our first day is to check out the extravehicular mobility units (EMU's), NASA parlance for "spacesuits." My colleagues Bruce McCandless and Kathy Sullivan are prepared to venture outside the orbiter during the deployment in the event the telescope malfunctions. Of particular concern is the extension of the antennas and the two solar-cell arrays. Before lifting the



Space-walk veterans McCandless (left) and Sullivan practice the procedures they will use should one of HST's solar-cell arrays fail to unfurl in orbit. This rehearsal took place in an underwater simulation tank at NASA's Marshall Space Flight Center in Alabama. Courtesy K. Sullivan.

various appendages using radio commands.

There is concern that the fragile solar-cell arrays may damage themselves as they unfurl into space, so we watch very carefully, trying to detect any abnormalities. McCandless and Sullivan are standing by below, ready to don their spacesuits, depressurize the air lock, and leave the orbiter. More than 100 specialized tools have been fabricated that might be required now or on a later mission. For example, the first routine maintenance mission is scheduled for 1993. This time up, we hope neither the tools nor my space-walking crewmates will be needed.

A multitude of potential failures can make the RMS task extremely difficult. For example, a computer failure would shut down the arm's automated control and force me to move each joint separately. I have practiced this method of operation many times, but it is extremely time-consuming. We might also lose the digital display of the coordinates of the end effector or payload center of mass. This would complicate the task because the critical positions — low-hover, high-hover, and finally the deploy position — are accurately defined by sets of these coordinates. So I have with me computer-generated views of how everything should appear at these critical junctures. I have trained to position HST accurately even if the displays or the computer support fail. The only position where accuracy is critical is the one for the deployment itself.

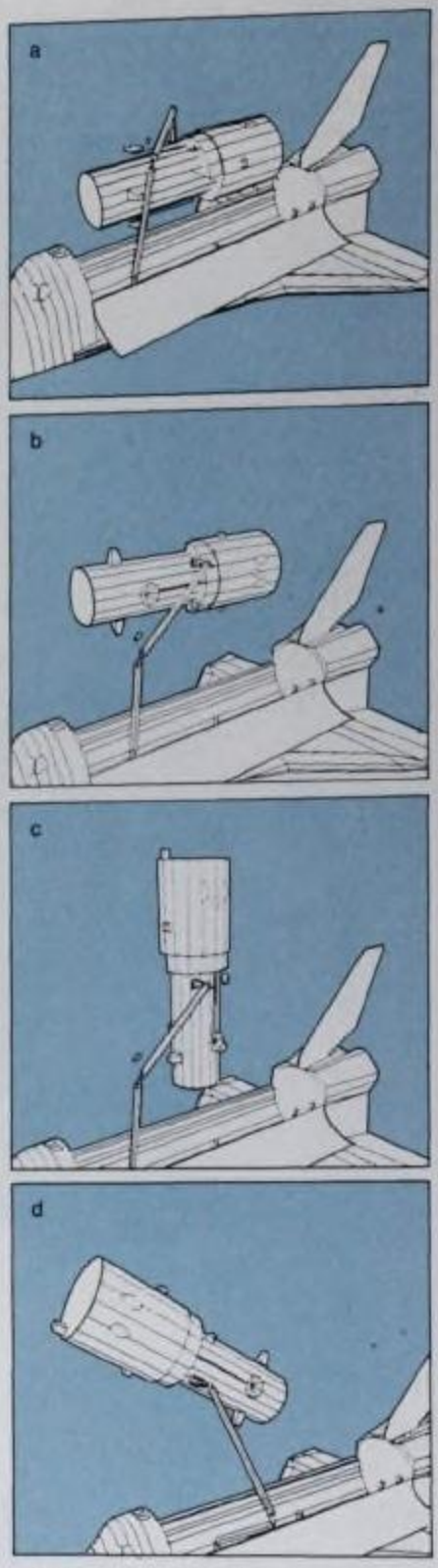
In planning this mission, two options were considered in the event that the RMS fails completely. One plan was sending McCandless and Sullivan outside to lift HST bodily out of the bay. The other was to open the latches and fly the orbiter out from under the telescope. In the end we chose the latter option. It should work without imparting unwanted motion to HST, and my crewmates won't have to risk handling a large payload with tight clearances and poor visibility.

## LETTING GO

Assuming all goes well and the appendages are extended, Shriver maneuvers the orbiter to the release attitude. The telescope can be deployed only during a limited window in each orbit, since immediately thereafter it needs about 20 minutes of communication with the ground, plus another 20 minutes or so of daylight to align with and lock onto the Sun.

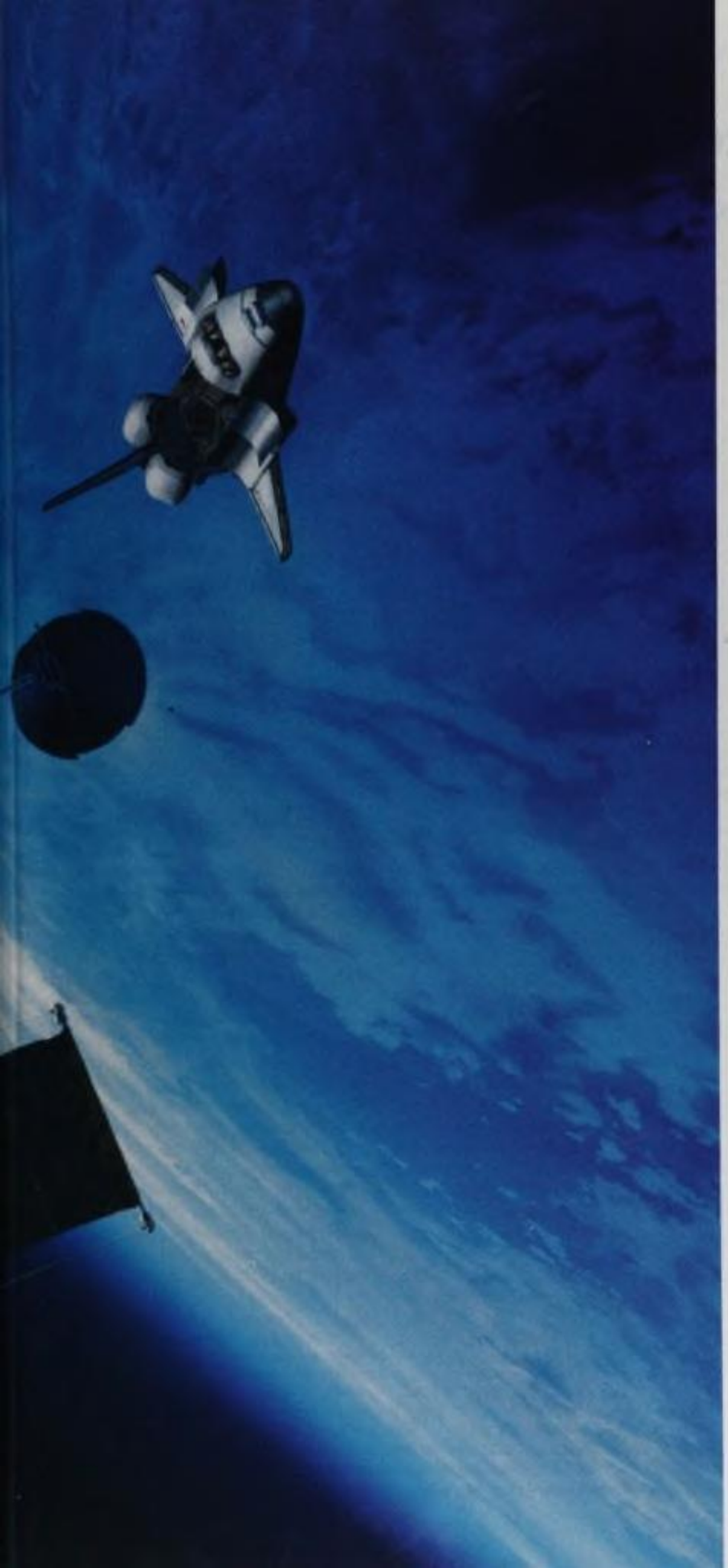
Our plan is to release HST in about the middle of the daylight pass on the 19th orbit. At the appointed time I squeeze a trigger on one of the RMS hand controllers, which loosens the snare wires in the end effector. Then I slowly pull the RMS away. The Hubble Space Telescope, at long last, is flying on its own. According to our flight plan, this moment occurs 1 day, 5 hours, and 24 minutes after launch. Approximately 30 seconds later Shriver fires the RCS jets to back *Discovery* gently away from the telescope. Another separation burn is made a little later. For the time being our job is done, and as we head below for some sleep the two craft gradually drift apart.

For the next day or so, ground controllers give the telescope a complete check-




NASA diagrams show four key events in the deployment sequence for the Hubble Space Telescope: *a*, the "low hover" position, with the telescope 15 feet above the cargo bay; *b*, "high hover," 27½ feet up; *c*, 90° into the telescope's end-over-end flip; and *d*, the tipped-down position in which the solar-cell arrays and antenna booms will be extended and the telescope released.

Only after the Space Shuttle *Discovery* has moved some 45 miles from the telescope will the door that protects its optics be raised. The aperture door should open about 32 hours after HST's release, and its six instruments will feast on starlight in the hours and days thereafter. This painting by Paul Hudson is courtesy the NASA Art Program.



out, while we look on from a distance of about 45 miles. The orbiter stays within rendezvous distance of HST for 48 hours after letting it go. If all its systems are functioning well, on day 5 we begin to prepare for reentry and landing.

Should HST need our help, we have enough time and propellant to return to it once. But all we could do on this mission would be to open the aperture door if it fails to open 32 hours after release. (The aperture door remains closed while HST is attached to the RMS — and in fact while the orbiter is anywhere nearby — to protect the optics from becoming contaminated by thruster exhaust.)

Should the door not open when commanded to do so, Shriver and Bolden would first maneuver the orbiter to within 35 feet of the telescope. Then I would have to grapple it once more with the RMS, though this time the task might be trickier because HST and the orbiter are both free-flying objects. To help me, ground controllers would first try to stow the antenna boom on the same side as the grapple fixtures; otherwise it could impede my view of the fixtures and pose an obstacle to be avoided with the RMS. I would maneuver HST down to a position just above the payload bay. Then McCandless and Sullivan would exit the orbiter and do what they could to repair the malfunction. After the repairs were made, I would release the telescope just as before.

At the end of this second deployment, the orbiter would need to be readied to reenter and land right away. If a subsequent malfunction occurred, we would not have enough propellant for a return visit. Nor will we have enough to bring the telescope back to Earth for repairs, once it is released from the RMS.

The OMS burn to get us out of orbit and the subsequent landing should be as usual, except that we need to use all of our remaining propellant to get home. Our landing is to be on a lake-bed runway at Edwards Air Force Base in California, 5 days and 47 minutes after liftoff. The STS 31 mission will mark the end of HST's long period of preparation and anticipation. But it also marks the beginning of a new era in astronomy, during which we may answer some of the most fundamental questions about the nature of our universe.

*STS 31 will be Steven Hawley's third trip aboard the Space Shuttle. He became an astronaut in 1978, the year after receiving a Ph.D. in astronomy from the University of California, Santa Cruz. Hawley is now deputy chief of the astronaut office at NASA's Johnson Space Center in Houston, Texas.*

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# Sky & Telescope



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# Other Suns, Other Worlds

WE KNOW they're out there. Statistics alone say the galaxy must be teeming with planets. Already clouds, rings, and disks of debris — perhaps the embryos of other worlds — have been detected around a number of stars. Perhaps the discovery of an extrasolar planet is not far in the future. But for the moment, the realm of extrasolar planets remains solely in the imagination.

For space artists, these unseen worlds have long been a favorite subject. Somehow, the allure of an alien surface is compelling — especially as a vantage point for viewing such celestial spectacles as double stars, galaxies, supernovae, and black holes. On these four pages is a sampling of recent portrayals of such undiscovered scenery. All the paintings are copyrighted by the artists who created them.

*Above:* An Earthlike planet is surrounded by the remains of a shattered moon in this view by Joe Tucciarone. *Right:* A double star sets in an alien sky in this portrayal by James Hervat.

*Top:* A cloudscape frames a Saturnlike planet in this view by Kim Poor. *Left:* A crater-pocked planet far above the plane of a spiral galaxy is the setting for Kurt Burmann's painting. *Above:* Waves break on the shore of one member of a triple-planet system in this portrayal by Joe Tucciarone. *Facing page:* On a world with an atmosphere rich in chlorine the glow of sunset lights a green sky. A double planet hangs amid the stars. Painting by Kim Poor.

*Top:* In contrast to the preceding pages, this rendering by Rick Sternbach is of a specific celestial wonder. The bizarre object SS 433 provides a spectacular sky show above the cratered, radiation-soaked surface of an imaginary world. *Bottom:* A supernova in a nearby galaxy lights a gas-giant planet and its moon, as portrayed by Paul DiMare.